

Appendix C—Series Capacitor Bank Support Structures

C.1. General

These provisions are applicable only to the seismic evaluation of series capacitor bank support structures identified as qualified to the high or moderate seismic qualification level per Section 4.3.

C.2. Seismic Qualification and Design

The fixed series capacitor bank platform and support structure shall be qualified in accordance with IEEE Std. 693, Annex O, and the provisions contained herein. All capacitor bank platform structures shall utilize columns and diagonal bracing systems built with insulators between the platform and foundation for lateral force resistance. Bracing systems can utilize either tension-only or tension-compression members.

For structures with tension-only diagonal bracing systems, structural analysis shall be performed utilizing either site-specific developed time response histories, or IEEE Std. 693 developed time response history record. The seismic response history procedures in the latest version of ASCE 7 shall be used. Time histories shall be scaled to envelope the IEEE Std. 693 performance level response spectrum for 2% damping. For tension-only bracing systems, the loss of pre-tensioning during response history analysis shall be explicitly modeled. All connections and components of the bracing system shall be modeled.

For diagonal bracing members consisting of materials other than structural steel, structural capacity shall be established by means of testing and shall include all connection components that comprise the bracing assembly (i.e. shackles, pins, clevises, etc.). Testing shall include the development of load-deflection curves (loading and unloading) required for the structural analysis model. Results of test data shall be included in the final seismic qualification report. All bracing member capacities shall have a tested minimum factor of safety of 1.2 at the IEEE Std. 693 performance level demands. Further, for tension-only bracing, the minimum factor of safety shall be 1.5. Shackles, pins, clevises and other hardware shall be provided with a minimum 2.0 factor of safety at the IEEE Std. 693 performance level demands.

The use of supplemental damping or response modification devices shall be acceptable provided the demonstrated system response meets the IEEE Std. 693 performance level requirements. All nonlinear components of the lateral force resisting system shall be explicitly modeled to capture behavior and effect on the support structure system. The performance characteristics of all supplemental damping or response modification devices, both linear and nonlinear, shall be established by component testing and shall demonstrate adequacy for entire range of expected forces and displacements. The performance characteristics shall be explicitly used in the computer model.

The top of the capacitor bank platform shall not deflect in any horizontal or vertical direction more than $H/50$ when subject to IEEE Std. 693 performance level demands, where “H” is equal to the height of the capacitor bank/support structure platform interface as measured from the top of the foundation.

The company recommends the support structure columns and diagonal braces be connected to and supported by steel pedestals embedded in the concrete foundation, rather than directly connected to concrete pedestals. The use of cast-in-place anchor rods or post-installed anchors is discouraged due to difficulty in satisfying requirements of ACI 318, Appendix D provisions. However, if either cast-in-place or post-installed anchors are provided, the ACI 318, Appendix D provisions shall be used and all concrete shall be assumed to be cracked for purpose of analysis.

Calculations shall be submitted to demonstrate the performance of the capacitor bank system as specified above. The submittal shall include a Seismic Qualification Report prepared in accordance with IEEE Std. 693, Annex S. The Report shall contain a comprehensive narrative that clearly explains all analysis & design assumptions along with final conclusions and recommendations. In addition, electronic file copies of input and output used for the structural analyses shall be provided on CDs or DVDs such that the company can review the computer file in STAAD. If software other than STAAD is used for analyses, then electronic versions of files importable into STAAD (ex. CIS/2 format) shall also be included (in addition to original files). Computer files will be used as part of technical review and validation of proper modeling methodology and analysis results.

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Appendix D—Standby Generators

D.1. General

These provisions are applicable only to the seismic evaluation of standby generators identified as qualified to the high or moderate seismic qualification level per Section 4.3.

Generator configuration shall meet the project specific requirements which may include one of the following:

- Generator mounted directly on a concrete foundation with a separate fuel tank
- Generator mounted on a sub-base fuel tank that is supported by a concrete foundation, where the top of the fuel tank is used as a working/walking platform
- Generator mounted on a sub-base fuel tank that is supported by a concrete foundation, with a separate grated platform used as a working/walking platform

Seismic qualification of the generator, sub-base fuel tanks and platforms shall be in accordance with the applicable provisions in IBC, ASCE 7, ICC-ES AC 156 and Section D.2.

All working/walking platform surfaces and approach steps shall be OSHA compliant, free of slip/trip hazards and be equipped with fall protection when applicable. Platforms and approach steps shall be designed for a minimum snow load of 30 pounds per square foot (psf), uniform live load of 50 psf and concentrated live load of 500 pounds.

Steel design shall be in accordance with the applicable provisions in AISC and AISI, with due consideration to effects of buckling and prying at bolted connections.

Post-installed anchors (adhesive or mechanical anchors) shall be used to anchor the generator, fuel tank, and platform support steel to concrete foundations. Adequate clearance shall be provided to enable the installation of the anchors after the equipment is set in place on the concrete foundation.

D.2. Seismic Qualification Methods

1. The generator set should be qualified by shake-table testing that meet or exceed the parameters below:
 - a. Building code/referenced standards, IBC 2009/ASCE 7
 - b. Test criteria, ICC-ES AC 156
 - c. $S_{DS} (g) = 1.67$
 - d. $z/h = 1.0$
 - e. $A_{FLX-H} (g) = 2.67$
 - f. $A_{FLX-V} (g) = 1.12$
An $I_p = 1.5$ shall be assumed for evaluating functional requirements after testing (Ref ICC – ES AC156 Section 6.8.2).

For generators supported on top of sub base fuel tanks additional calculations shall be provided to verify that the support system is dynamically better (will transmit lower accelerations to the generator) than the support used for the shake-table test.

2. The enclosure, fuel tank, other components, connections and anchorages that are not shake table tested must be analyzed and designed to the following ultimate (LRFD) seismic forces:
 - a. $F_{p\text{-hori}} = 3.76 W_p$
 - b. $F_{p\text{-vert}} = 1.12 W_p$

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